

SIGNIFICANT RESEARCH ACCOMPLISHMENTS

A. Since 1993

My most significant research achievement in the last five years has been to improve the preparative-scale DOC fractionation for the hydrophilic fractions. Separation of the hydrophilic DOC fractions from inorganic salts is a very difficult separation on which I have been working my whole professional career. Hydrophilic organic colloids are first isolated by tangential flow ultrafiltration coupled with dialysis for final purification. The ultrafiltered sample is then cation exchanged with sodium to remove complexing polyvalent cations, and concentrated 50-fold by reverse osmosis. After removing the hydrophobic NOM fractions on XAD adsorbent resins, the majority of the salts are separated from the DOC fractions by zeotropic distillation with acetic acid. Final purification is accomplished by removal of sulfate by precipitation of barium sulfate in acetic acid, removal of phosphate by precipitation of trilitium phosphate at pH 12, removal of borate as volatile trimethyl borate by evaporation with methanol, reduction of nitric acid to gaseous nitrogen dioxide with formic acid, and removal of silica by selective dissolution of hydrophilic DOC from silica gel at pH 2. My first report on this work was at a NOM workshop in Poitiers, France (Leenheer, 1996).

This work has resulted in providing about half of my research funding for the past five years. Projects 2-4 of my present research assignment have resulted from this work, and these projects are all renewals of previous projects with the listed agencies. I have just completed a three-year project for the University of Washington entitled "Novel and advanced approaches for concentrating, isolating, and characterizing natural organic matter" and have completed a FY 1997 project for the Florida district entitled "Chemistry of chlorination reactions with natural organic matter in surface-and ground-waters from northern Florida". Several publications from these projects are in the process of writing and review. The main research interests that result in funding of these projects are (1) Reactivity of hydrophilic DOC fractions with chlorine to produce disinfection by-products, (2) Treatability of hydrophilic DOC fractions to remove them from drinking water, and (3) Understanding of the natural and contaminant biogeochemistry of DOC production, degradation, reactivity, and transport. The improvement of the DOC fraction isolation has allowed the addition of infrared spectrometry as a characterization tool because interfering inorganic solutes have been removed.

Structural studies of the proton and metal-binding structures of fulvic acid isolated from the Suwannee River, Georgia, were conducted. This fulvic acid was assessed for its ability to bind Ca^{2+} , Cd^{2+} , Cu^{2+} , Ni^{2+} , and Zn^{2+} ions before and after extensive fractionation that was designed to reveal the nature of metal-binding functional groups. The binding constant for Ca^{2+} ion had the greatest increase of all the ions in a "metal binding" fraction that was selected for intensive characterization for the purpose of building quantitative average model structures. The "metal binding" fraction was characterized by quantitative ^{13}C -NMR, ^1H -NMR, and FT-IR spectrometry, and elemental, titrimetric, and molecular weight determinations. The characterization data revealed that carboxyl groups were clustered in short chain aliphatic dibasic acid structures. The Ca^{2+} binding data suggested that ether-substituted oxy-succinic acid structures are good models for the metal binding sites. Structural models were derived based upon oxidation and photolytic rearrangements of a cutin, lignin, and tannin precursors. These structural models rich in substituted dibasic acid structures revealed polydentate binding sites with metal ions of both inner sphere and outer sphere type binding. The majority of the fulvic-acid molecule was involved with metal binding rather than a small substructural unit. Four reports on this study are being submitted for publication. With regards to proton-binding structures in fulvic acid from the Suwannee River, the strong-acid characteristics indicated that anion stabilization through intramolecular hydrogen bonding between carboxyl groups clustered on aliphatic, oxygen-heterocyclic rings was the most important factor in reducing carboxyl pKa values to as low as 0.5. Specific strong-acid functional groups, such as sulfonic acids, were not found to be important although they may be important for certain humic substances. Intramolecular hydrogen bonding has acid-weakening effects that are as pronounced as the acid strengthening effects for carboxyl groups that are hydrogen-bonded to carboxylate anions. The proton-binding studies were reported in two sequential reports published in Environmental Science and Technology (Leenheer, Wershaw, and Reddy, 1995).

My last significant achievement is the publication of the book Nuclear Magnetic Resonance Spectroscopy in Environmental Chemistry in which I am an editor, am primary author of three chapters, and am coauthor of a forth chapter. I essentially organized and wrote the sections dealing with NMR characterization of natural organic matter. This book was structured and written to be useful to NMR users in environmental chemistry studies.

B. Previous to 1993

The most significant research achievement of my career has been the DOC classification scheme I first proposed in the U.S. Geological Survey Journal of Research in 1976 (Leenheer and Huffman, 1976). This hierarchical classification determines DOC based upon its concentration (level 1), polarity (level 2), acid-bases character (level 3), compound class (level 4), specific compound (level 5), and compound complexes (level 6). This DOC classification has played a part in every research study of which I have undertaken since 1976, and it is the basis of my present research project "Comprehensive organic analyses of water". The DOC classification was initially used as an analytical classification called "DOC fractionation analyses" to determine organic carbon fractionation only at the first three levels; however, it has been modified to preparatively fractionate and isolate DOC for studies at levels 4, 5, and 6. The DOC fractionation analyses is performed on a commercial basis by Huffman Laboratories, Wheatridge, Colorado, and it has been performed by a number of laboratories in academia and industry for organic geochemical studies of DOC in the environment.

The DOC fractionation approach has been especially useful for the preparative isolation and analyses of humic substances in water. One of my activities has been to organize and coordinate interdisciplinary research studies that approximate the various chemical structures found in dissolved humic substances isolated from diverse environments into quantitative structural models. The most significant study, "Humic Substances in the Suwannee River, Georgia: Interactions, Properties, and Proposed Structures", is a 16-chapter publication that is the most comprehensive investigation of natural organic solutes in water ever attempted (Averett and others, 1989). This structural model approach was recently applied to describe a number of aquatic fulvic acids isolated from a number of "end member" environments. This study, published as book chapter entitled "Chemistry of dissolved organic matter in rivers, lakes, and reservoirs" (Leenheer, 1994) has identified two major structural classes of fulvic acid: 1) A fulvic acid derived from allochthonous inputs that is characterized by residual tannin, lignin, and carbohydrate structures, and 2), a fulvic acid derived from autochthonous inputs that is characterized as oxidized aliphatic alicyclic hydrocarbons derived from unsaturated lipids. Fulvic acids derived from various rivers, lakes, and reservoirs can be described as mixtures of the two "end member" types of fulvic acid.

As one of the leaders of the research team that conducted the Mississippi River research project, I designed the system that fractionated and isolated sand, silt, colloids, and dissolved constituents from large volumes of water (Leenheer and others, 1989). In this study, I conducted the organic matter characterization and transport in the dissolved, colloidal, and suspended-silt phases has been reported for the Mississippi River during ten sampling cruises from 1987-1992. Organic carbon concentrations in the dissolved and suspended-silt phase is variable and depends on hydrology, geology, soil, season, and geographic variables. However, organic carbon concentrations in the colloidal phase are surprisingly invariant (about 0.1 mg C/L). The major difference between dispersed colloids in the colloid phase and aggregated colloids in the suspended silt phase is the greater amount of organic coatings on the clay colloids that act to disperse these colloids due to the buildup of negative charges from carboxyl groups in the organic coatings. A significant flux of organic and trace-metal contaminants, bound to these organic coatings, has been reported for the colloid phase by other researchers of the Mississippi River research project.

SCIENTIFIC LEADERSHIP

A. From May 1993 to December, 1995, I was chairman of a water resource subcommittee of a Jefferson County, Colorado, commission whose task was to establish a county development plan called "Future Jeffco". The subcommittee consisted of various government, industry, and private citizen individuals who were interested in water resource issues related to future county development. As a result of my leadership in this county plan, the county planning commission has contacted the Colorado District to discuss various groundwater and surfacewater studies that might be funded related to sewage contamination in the unincorporated areas of the County.

B. In April of 1995, I along with George Aiken assumed responsibility for rescuing an American Water Works Association Research Foundation (AWWARF) project in which the commitment of the U.S. Geological Survey was endangered by the retirement of Ron Malcolm. This project was completed by George and I, and resulted in my present project with the Metropolitan Water District of Southern California. I interact frequently with the management of the American Water Works Association Research Foundation that is based in Denver; giving them technical advice and reviewing their project proposals. I also have collaborated with personnel in various water treatment utilities and researchers at the University of Washington, University of Colorado, and University of Poitiers, France, in the conduct of these AWWARF funded projects

C. My responsibilities as project chief have expanded as a result of taking on personnel from other project chiefs and from the NRP freeze on new project chief positions. I took on Larry Barber when Mike Thurman became Chief of the Branch of Regional Research. Larry has been very successful in developing his own program with numerous sources of OFA funding in his Boulder laboratory, and my project management responsibilities have added complexity as Larry's program grows, especially because of his remote location relative to my laboratory. In January, 1997, I took on Colleen Rostad when Ron Rathbun retired, and Colleen is beginning to develop her own OFA funding and is supervising the research of a graduate student. These expanded project management responsibilities have limited my intended conversion of my cooperator reports into journal articles

SCIENTIFIC AND PUBLIC SERVICE

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No elective offices or committee assignments have been held

B. Technical Presentations: (Only those listed for which no publications resulted)

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Leenheer, J.A., 1984, Interfacial processes significant in the diagenesis of natural organic substances in water. Gordon Research Conference, New Hampton, New Hampshire. INVITED

Leenheer, J.A., 1987, Effects of salinity on solubility and stability of humic substances in water. Penrose Conference, Geological Society of America, 1987, Oxnard, California. INVITED

Leenheer, J.A., 1987, The concept of a number-average structural model of fulvic acid. Gordon Research Conference, Newport, Rhode Island. INVITED

Leenheer, J.A., 1988. Isolation and composition of dissolved hydrophilic organic substances in certain natural waters. Annual Meeting of American Society of Limnology and Oceanography, Boulder, Colorado. INVITED

Field, J.A., Leenheer, J.A., and Thorn, K.A., 1989, Techniques for isolation and purification of anionic surfactant degradation products in water. 31st Rocky Mountain Conference on Analytical Chemistry, Denver, Colorado PRESENTED

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Leenheer, J.A., 1992, Conservative transport of colloidal organic matter in the lower Mississippi River. 203rd American Chemical Society National Meeting, San Francisco, California PRESENTED

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Jurkiewicz, A., Leenheer, J. A., and Maciel, G. E., 1993, Quantitativeness in the analysis of humic and sediment samples by solid-state ¹³C-NMR spectroscopy: 205th American Chemical Society National Meeting, Denver, Colorado. PRESENTED

Leenheer, J.A., 1993, Organic contamination of the Mississippi River from industrial and municipal wastewaters. Upper Mississippi River Basin Association Meeting, Minneapolis-St. Paul, Minnesota. INVITED.

Leenheer, J. A. and Rostad, C. E., 1993, Transport of suspended organic matter in the Mississippi River: 1993 Annual Meetings of the American Society of Limnology and

Oceanography and Society of Wetland Scientists, Edmonton, Alberta, Canada. PRESENTED

Leenheer, J. A. and Rostad, C. E., 1993, Transport of suspended organic matter in the Mississippi River: 25th Annual Meeting of the Mississippi River Research Consortium, LaCrosse, Wisconsin. PRESENTED

Noyes, T. I. and Leenheer, J. A., 1993, Chemical structure of dissolved humic substances in various aquatic environments using proton nuclear magnetic resonance (1H-NMR) spectrometry: 35th Rocky Mountain Conference on Analytical Chemistry, Denver, Colorado. PRESENTED

Barber, L. B., II., Tabor, C. F., Jr., Leenheer, J. A., Pereira, W. E., and Writer, J. H., 1994, Environmental fate of organic contaminants in the Mississippi River: 207th American Chemical Society National Meeting, San Diego, California, PRESENTED

Leenheer, J. A., Barber, L. B., II., and Rostad, C. E., 1994, Contrasts in the organic geochemistry of water and sediment between the Upper and Lower Mississippi River: Summer Symposium of the American Water Resources Association, "Effects of Human-Induced Changes on Hydrologic Systems", Jackson Hole, Wyoming, PRESENTED

Leenheer, J. A., Brown, G. K., and Wershaw, R. L., 1994, Measurement of carboxyl-group acidity of pKa1 near 1.0 in fulvic acid from the Suwannee River, Georgia: 207th American Chemical Society National Meeting, San Diego, California. PRESENTED

Leenheer, J.A., and Meade, R.H., 1994, A contaminant survey of the Mississippi River, 1994. Midwest Regional Chapter Meeting of the Society of Environmental Contamination and Toxicology, La Crosse, Wisconsin. INVITED

Leenheer, J.A. and Meade, R.H., 1994, A survey of contaminants in the Mississippi River, 1987-1992, International Conference on Sustaining the Integrity of Large Floodplain Rivers, La Crosse, Wisconsin INVITED PAPER

Leenheer, J. A., Wershaw, R. L., and Reddy, M. M., 1994, Strong-acid, carboxyl-group structures in fulvic acid from the Suwannee River, Georgia: Seventh International Meeting of the International Humic Substances Society (IHSS), St. Augustine, Trinidad and Tobago, INVITED

Rostad, C. E., Leenheer, J. A., and Monsterleet, S. G., 1994, Transport of toxic organic compounds associated with silt and colloid in the Mississippi River: Summer Symposium of the American Water Resources Association, "Effects of Human-Induced Changes on Hydrologic Systems", Jackson Hole, Wyoming. PRESENTED

Leenheer, J.A., 1995, Contaminants in the Mississippi River, Mississippi River embayment NAWQA Meeting, Memphis, Tennessee INVITED

Leenheer, J.A., 1996, Water quality issues in the Mississippi River. The Delta Conference (sponsored by the Lower Mississippi River Basin Association), Memphis, Tennessee INVITED

Leenheer, J.A., 1996, The importance of clustering of acidic structures in humic substances for proton and metal binding. 8th International Humic Substances Society Meeting, Wroclaw, Poland. INVITED

C. Rendering Scientific Judgment

1. I served on the Scientific Committee on Problems in the Environment/United Nations Environmental Program Workshop on Transport of Carbon and Minerals in Major World Rivers. I served on this committee in Hamburg, Germany in 1982; Caracas, Venezuela in 1984, Tianjin, China in 1985; Fairbanks, Alaska in 1986, and Texel, The Neatherlands, in 1987. I was chairman of a committee on analytical methods.

2. I represented the Mississippi River Research Project at the Adaptive Environmental Assessment Workshop on the Upper Mississippi River in Winona, Minnesota, in 1995 and 1997. This workshop, sponsored by the Upper Mississippi River Basin Association, brought together about 50 representative from government, industry, and various citizen organizations, to assemble a predictive computer model of the Upper Mississippi River that would guide state and federal policy makers on remediation strategies for various environmental and navigation problems.

3. I served as an editor of the book published by Oxford University Press in 1997, Nuclear Magnetic Resonance Spectroscopy in Environmental Chemistry. I organized and contributed to the book section "Nutrient and Organic Matter Cycling in the Environment.

D. Lectureships and Other Academic Services

1. Graduate Students, Term of Support, Thesis Title, School, Degree

- a. Steve W. Cowling, 1977-1979, Evaluation of processed oil shale and sediments as sorbents for waste organic solutes , produce by in situ oil shale retorting, Colorado School of Mines, MS
- b. Harold A. Stuber, 1977-1980, Selective concentration and isolation of aromatic amines from water, University of Colorado, PhD
- c. Jennifer A. Field, 1987-1990, Fate and transformations of surfactants in sewage-contaminated groundwater, Colorado School of Mines, PhD
- d. Jeffrey H. Writer, 1990-1992, Sewage contamination in the Upper Mississippi River as measured by the fecal sterol coprostanol, University of Colorado, MS
- e. Charles F. Tabor, Jr., 1991-1993, The occurrence and fate of linear alkylbenzene sulfonate in the Mississippi River: A molecular indicator of sewage contamination, University of Colorado, MS
- f. Mark A. Nanny, 1991-1994, Identification and characterization of aquatic soluble unreactive phosphorus in the hydrosphere with 31-phosphorus Fourier transform nuclear magnetic resonance spectroscopy and high performance liquid chromatography, University of Illinois, PhD. (I provided partial laboratory support and sampling support through the Mississippi River Research Project. I served on Mark's thesis committee)
- g. Gregory K. Brown, 1994-1996, Structural characterization of the metal-complexing sites of Suwannee River fulvic acid, Colorado School of Mines, MS

2. Seminars Presented at Graduate Schools

- a. Polyethylene glycol residues in the lower Mississippi River, 1991, Northern Illinois University.

- b. Structural chemistry of humic substances, 1993 University of Kansas

- c. Nature of dissolved organic matter in Norman landfill leachate, 1997, University of Oklahoma

E. Technical Training Provided

Fundamental concepts in aquatic organic chemistry. Organic substances in water, Taught at the National Training Center in 1982, 1983, 1984, 1985, 1986, 1988, 1990.

F. Special Assignments: . I received a research grant from the Organization of American States to study the nature of dissolved organic matter in the Amazon at the Brazilian Institution Nacional de Pesquissas da Amazonia in Manaus, Brazil, 2/78 to 4/78.

G. Other Technical Activities: A large American Water Works Association Research Foundation Report entitled "Novel and Advanced Approaches for Concentrating, Isolating, and Characterizing Natural Organic Matter" is being prepared. Mark Benjamin of the University of Washington is the editor, and George Aiken, and Jean-Philippe Croue of the University of Poitiers are the other investigators on this work. This work has occupied about 30% of my time for the last two years.

OUTREACH AND INFORMATION TRANSFER

A. Mississippi River Research Project - See talks given in item 14B, workshop participation in Part: Scientific and Public Service, Item:C2, and publications in Bibliography.

B. "Future Jeffco" Committee - See Part: Scientific Leadership, Item: A

C. SCOPE/UNEP Project - See Part: Scientific and Public Service, Item: C1

D. OFA Projects - See Part: Scientific and Public Service, Item: VG

HONORS, AWARDS, RECOGNITION, ELECTED MEMBERSHIP

Non-Recurring Special Achievement Award - 6/81, Superior Service Award - 8/83. Sustained Special Achievement Award - 5/85. Meritorious Service Award - 7/87. Certificate of Appreciation, American Chemical Society - 4/90. Non-Recurring Special Achievement Award - 10-92.

I served as Research Advisor to the Water Chemistry Discipline from 1984 to 1988. In 1987 as Research Advisor, I took a leading role in starting the Mississippi River Research Project. During this project, I arranged a cooperative study between the U.S. Geological Survey and the U.S. Fish and Wildlife Service to study PCB contamination in water, sediment, and fish in the upper Mississippi River. I also conducted and

coordinated studies of sewage-derived contaminants, and conducted fundamental research on the nature of organic substances in the river and their interaction with various contaminants.

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Leenheer, J.A., 1993, Organic contamination of the Mississippi River from industrial and municipal wastewaters. Upper Mississippi River Basin Association Meeting, Minneapolis-St. Paul, Minnesota. INVITED.

Leenheer, J. A. and Rostad, C. E., 1993, Transport of suspended organic matter in the Mississippi River: 1993 Annual Meetings of the American Society of Limnology and Oceanography and Society of Wetland Scientists, Edmonton, Alberta, Canada. PRESENTED

Leenheer, J. A. and Rostad, C. E., 1993, Transport of suspended organic matter in the Mississippi River: 25th Annual Meeting of the Mississippi River Research Consortium, LaCrosse, Wisconsin. PRESENTED
Noyes, T. I. and Leenheer, J. A., 1993, Chemical structure of dissolved humic substances in various aquatic environments using proton nuclear magnetic resonance (¹H-NMR) spectrometry: 35th Rocky Mountain Conference on Analytical Chemistry, Denver, Colorado. PRESENTED

Barber, L. B., II, Tabor, C. F., Jr., Leenheer, J. A., Pereira, W. E., and Writer, J. H., 1994, Environmental fate of organic contaminants in the Mississippi River: 207th American Chemical Society National Meeting, San Diego, California, PRESENTED

Leenheer, J. A., Barber, L. B., II, and Rostad, C. E., 1994, Contrasts in the organic geochemistry of water and sediment between the Upper and Lower Mississippi River: Summer Symposium of the American Water Resources Association, "Effects of Human-Induced Changes on Hydrologic Systems", Jackson Hole, Wyoming, PRESENTED

Leenheer, J. A., Brown, G. K., and Wershaw, R. L., 1994, Measurement of carboxyl-group acidity of pKa1 near 1.0 in fulvic acid from the Suwannee River, Georgia: 207th American Chemical Society National Meeting, San Diego, California. PRESENTED

Leenheer, J.A., and Meade, R.H., 1994, A contaminant survey of the Mississippi River, 1994. Midwest Regional Chapter Meeting of the Society of Environmental Contamination and Toxicology, La Crosse, Wisconsin. INVITED

Leenheer, J.A. and Meade, R.H., 1994, A survey of contaminants in the Mississippi River, 1987-1992, International Conference on Sustaining the Integrity of Large Floodplain Rivers, La Crosse, Wisconsin INVITED PAPER

Leenheer, J. A., Wershaw, R. L., and Reddy, M. M., 1994, Strong-acid, carboxyl-group structures in fulvic acid from the Suwannee River, Georgia: Seventh International Meeting of the International Humic Substances Society (IHSS), St. Augustine, Trinidad and Tobago, INVITED

Rostad, C. E., Leenheer, J. A., and Monsterleet, S. G., 1994, Transport of toxic organic compounds associated with silt and colloid in the Mississippi River: Summer Symposium of the American Water Resources Association, "Effects of Human-Induced Changes on Hydrologic Systems", Jackson Hole, Wyoming. PRESENTED

Leenheer, J.A., 1995, Contaminants in the Mississippi River, Mississippi River embayment NAWQA Meeting, Memphis, Tennessee INVITED

Leenheer, J.A., 1996, Water quality issues in the Mississippi River. The Delta Conference (sponsored by the Lower Mississippi River Basin Association), Memphis, Tennessee INVITED

Leenheer, J.A., 1996, The importance of clustering of acidic structures in humic substances for proton and metal binding. 8th International Humic Substances Society Meeting, Wroclaw, Poland. INVITED

C. Rendering Scientific Judgment

1. I served on the Scientific Committee on Problems in the Environment/United Nations Environmental Program Workshop on Transport of Carbon and Minerals in Major World Rivers. I served on this committee in Hamburg, Germany in 1982; Caracas, Venezuela in 1984, Tianjin, China in 1985; Fairbanks, Alaska in 1986, and Texel, The Netherlands, in 1987. I was chairman of a committee on analytical methods.

2. I represented the Mississippi River Research Project at the Adaptive Environmental Assessment Workshop on the Upper Mississippi River in Winona, Minnesota, in 1995 and 1997. This workshop, sponsored by the Upper Mississippi River Basin Association, brought together about 50 representative from government, industry, and various citizen organizations, to assemble a predictive computer model of the Upper Mississippi River that would guide state and federal policy makers on remediation strategies for various environmental and navigation problems.

3. I served as an editor of the book published by Oxford University Press in 1997, Nuclear Magnetic Resonance Spectroscopy in Environmental Chemistry. I organized and contributed to the book section "Nutrient and Organic Matter Cycling in the Environment."

D. Lectureships and Other Academic Services

1. Graduate Students, Term of Support, Thesis Title, School, Degree

a. Steve W. Cowling, 1977-1979, Evaluation of processed oil shale and sediments as sorbents for waste organic solutes, produce by in situ oil shale retorting, Colorado School of Mines, MS

b. Harold A. Stuber, 1977-1980, Selective concentration and isolation of aromatic amines from water, University of Colorado, PhD

c. Jennifer A. Field, 1987-1990, Fate and transformations of surfactants in sewage-contaminated groundwater, Colorado School of Mines, PhD

d. Jeffrey H. Writer, 1990-1992, Sewage contamination in the Upper Mississippi River as measured by the fecal sterol coprostanol, University of Colorado, MS

e. Charles F. Tabor, Jr., 1991-1993, The occurrence and fate of linear alkylbenzene sulfonate in the Mississippi River: A molecular indicator of sewage contamination, University of Colorado, MS

f. Mark A. Nanny, 1991-1994, Identification and characterization of aquatic soluble unreactive phosphorus in the hydrosphere with ³¹-phosphorus Fourier transform nuclear magnetic resonance spectroscopy and high performance liquid chromatography, University of Illinois, PhD. (I provided partial laboratory support and sampling support through the Mississippi River Research Project. I served on Mark's thesis committee)

g. Gregory K. Brown, 1994-1996, Structural characterization of the metal-complexing sites of Suwannee River fulvic acid, Colorado School of Mines, MS

2. Seminars Presented at Graduate Schools

a. Polyethylene glycol residues in the lower Mississippi River, 1991, Northern Illinois University.

b. Structural chemistry of humic substances, 1993 University of Kansas

c. Nature of dissolved organic matter in Norman landfill leachate, 1997, University of Oklahoma

E. Technical Training Provided

Fundamental concepts in aquatic organic chemistry. Organic substances in water, Taught at the National Training Center in 1982, 1983, 1984, 1985, 1986, 1988, 1990.

F. Special Assignments: . I received a research grant from the Organization of American States to study the nature of dissolved organic matter in the Amazon at the Brazilian Institution Nacional de Pesquissas da Amazonia in Manaus, Brazil, 2/78 to 4/78.

G. Other Technical Activities: A large American Water Works Association Research Foundation Report entitled "Novel and Advanced Approaches for Concentrating, Isolating, and Characterizing Natural Organic Matter" is being prepared. Mark Benjamin of the University of Washington is the editor, and George Aiken, and Jean-Philippe Croue of the University of Poitiers are the other investigators on this work. This work has occupied about 30% of my time for the last two years.

OUTREACH AND INFORMATION TRANSFER

A. Mississippi River Research Project - See talks given in item 14B, workshop participation in item 14C2, and publications in item 18.

B. "Future Jeffco" Committee - See Item 13A

C. SCOPE/UNEP Project - See Item 14C1

D. OFA Projects - See Items 11A and 14G

INVENTIONS, PATENTS HELD: None

HONORS, AWARDS, RECOGNITION, ELECTED MEMBERSHIP

Non-Recurring Special Achievement Award - 6/81, Superior Service Award - 8/83. Sustained Special Achievement Award - 5/85. Meritorious Service Award - 7/87. Certificate of Appreciation, American Chemical Society - 4/90. Non-Recurring Special Achievement Award - 10-92.